



December 15, 2004

TO: David L. Edwards/Gary J. McKee
NW Region, MS NB82-117

FROM: T. M. Allen/D.A. Williams
E&EP Geotechnical Division, 47365

SUBJECT: SR-202, OL-3498
SR 520 to Sahalee Way NE
Addendum to Final Geotechnical Report

Introduction

The recommendations in this memorandum are intended to supplement our Final Geotechnical Report dated November 8, 2004. As requested, we are supplying additional geotechnical recommendations for new Wall 22, and ground improvement measures along Wall 15B. Wall 22 is required to keep new fill within the Redmond Corporate limits and from encroaching on private property. The wall is located east of Pond 1A, as shown in Figure A-10. Wall 15B is located along the southern shoulder of the existing SR-202 alignment between Stations 210+50 and 223+65, as shown in Figure G-36. We anticipate that the majority of anticipated settlement of Wall 15B and the Phase 2 fill behind the wall will take approximately 9 months. We were asked to supply ground improvement recommendations that would accelerate the settlement and the required delay period for this area.

The analyses, conclusions, and recommendations presented in this report are based on the project description and site conditions that existed at the time of the field exploration. We assume the exploratory borings represent the subsurface conditions throughout the wall alignments. If different subsurface conditions are encountered or appear to be present, we should be contacted so that we can reevaluate our recommendations and assist you.

Field Exploration

No additional investigation was performed for the preparation of this addendum. At both locations, we used the existing test hole information. We used the existing test hole behind the proposed Wall 22 site, H-30-02 for our design. In the vicinity of Wall 15B, we used test holes B-5-92, MW-2-99, H-26-02, H-36, and H-37 for our design. Copies of the test hole logs were included in the final Geotechnical Report dated November 8, 2004.

We revised Figure A-10 to show the location of Wall 22 relative to H-30-02. The test hole locations for Wall 15B are shown in Figures A-18 and A-23 of the final Geotechnical Report.

Site Soil Conditions

At the Wall 22 site, there are three major soil units. The three units are as follows:

- Fill – Loose to medium dense, sand and gravel with silt. The thickness of this unit varies between 1 ft and 13 ft.
- Loose, sandy silt. The thickness of this unit varies up to 7 ft.
- Medium Dense to very dense, silty sand to silty gravel.

A typical soil cross-section for Wall 22 is shown on Figures G-35 and G-35A.

At the Wall 15B site, we grouped the four units in the following layers:

- Fill – Loose to medium dense, sand and gravel with silt. The thickness of this unit varies between 1 ft and 13 ft.
- Soft to medium, stiff elastic silt to medium stiff, lean clay with sand, (Lacustrine and/or slack water deposits). The thickness of this unit varies between 10 ft and 36 ft.
- Medium dense to dense silty sand. The thickness of this unit varies between 16 ft and 30 ft.
- Dense to very dense, poorly-graded to well-graded sand and gravel.

A generalized soil profile for Wall 15 is shown on Figure A-19 in the final Geotechnical Report.

Surface Water and Groundwater

The water levels have been monitored in test hole, H-30-02. H-30-02 is approximately 30 ft behind Wall 22. Ground water varies between elevations 101 ft and 102.6 ft, which is between 0.5 ft and 2 ft below the expected dredge line. The lowest level was observed during the late summer to early fall months (August to November). Water levels for Wall 15B are summarized on Table 10 in Appendix E of the final Geotechnical Report. The water levels are also listed on the test hole logs.

Geotechnical Recommendations – Wall 22

Wall 22 will be in a fill section which will support an expanded Pond 1A and an access road. In order to keep the fill within the Redmond Corporate limits and limit encroachment on private property, a new retaining wall is required. Another option would require lining the pond, and buying additional right-of-way to build a fill. It is our understanding that this option is not feasible.

Pond 1A will have a design pool elevation of 113 ft with an overflow pipe passing through the wall at approximate Wall Station 12+20. A drainage trench is planned approximately 6 ft

in front of the wall. The wall will be approximately 144 ft long with a maximum exposed height of 12 ft, and is located approximately 10 ft from the right-of-way boundary line.

We recommend a soldier pile wall be constructed at this location. We recommend the wall be embedded a minimum of 11 ft below the finished grade in front of the wall to provide an adequate factor of safety for overall stability. We also considered a Standard Plan Reinforced Concrete Retaining Wall. However, this wall type proved to be unstable for a pool elevation of 113 ft and therefore is not recommended.

Load and Resistance Factor Design (LRFD) methodology is currently used by the Bridge Office for structural design. For design, we have provided earth pressure diagrams for a soldier pile wall with the full hydraulic pressure of the new pond. Figures G-35 and G-35A provide the earth pressure diagrams for the Strength, Service and Extreme limit states, respectively.

To evaluate the soldier pile wall for the strength limit state, a resistance factor of 0.75 should be applied to the nominal passive pressure shown in Figure G-35. For Extreme Limit State, a resistance factor of 1.0 should be applied to the passive earth pressure in Figure G-35. We recommend that the passive pressure be applied over 3 pile diameters.

Geotechnical Recommendations – Wall 15B Ground Improvement

In order to accelerate settlement and reduce the “delay period” before paving, we recommend that wick-drains (vertical-drains) be used. Wick-drains consist of a relatively flat material with a plastic core formed to make channels with a geotextile cover. They are approximately 4 inches wide by 0.1 to 0.3 inches thick. The purpose of the core is to create low resistance flow channels in order to move water along the length of the wick-drain. The geotextile provides a surface that inhibits soil from penetrating into the core channels while allowing passage of water into the drain. Typically, the drains are driven into the ground in a diamond or rectangular pattern, and are spaced between 3 ft and 12 ft apart depending on the desired consolidation rate.

We understand the project office would like the majority of settlement to occur within 60 days after the wall and grading are completed. At this particular site, spacing of 4 ft is required to accomplish this task. A spacing of 3.5 ft would reduce this time to approximately 40 days. However, the estimated quantities would increase from approximately 125,116 LF to 139,163 LF of wick-drains, 10% increase of material cost. Figures G-36, G-36A, and G-36B, provide the typical wick-drain limits and typical cross sections for the wick drain option. In Appendix H, we have also provided a recommended special provision to be included in the contract documents.

To install the wick drains, pre-drilling in the existing roadway may be required. The existing asphalt overlay is likely underlain by a concrete pavement. We estimate that between 5 ft and 10 ft of pre-drilling would be required to install the wick-drains through the roadway surface and gravel base.

Construction Considerations

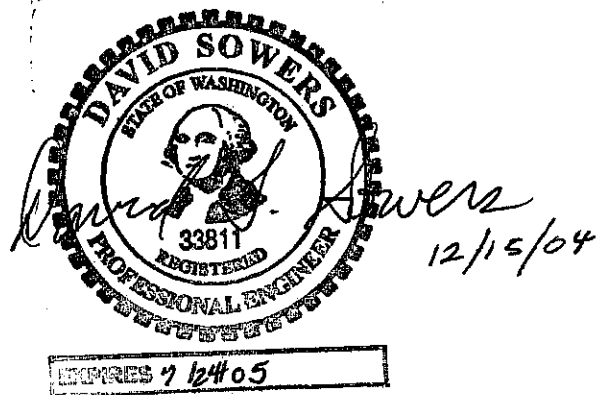
Additional construction considerations that require attention during design and construction of this project are as follows:

1. At Wall 22, we recommend that temporary casing be used in constructing the soldier pile shafts full depth. Medium stiff sandy silt and medium dense silty gravel with sand layers below the water table have the potential to cave during construction. Hard driving conditions for the casing should be expected if cobbles and boulders are encountered in the dense to very dense soil units.
2. An instrumentation and monitoring plan will be required to verify the expected settlement at the site along Wall 15B. The settlement monitoring plan presented in Section 7.1.5 of the final Geotechnical Report is still valid.
3. WSDOT does not allow Jetting method to install wick-drains. Static and/or vibratory methods are preferred.

Closure

We recommend that a Summary of Geotechnical Conditions be included in the contract documents to identify potential construction difficulties. The Summary of Geotechnical Conditions will be forwarded to Bridge and Structures after we have reviewed the PS&E package.

If you have any questions regarding this memorandum, please contact David Sowers at (360) 709-5418 or Donald Williams at (360) 709-5457.



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APPENDIX - A

T.25N. R.6E. W.M.

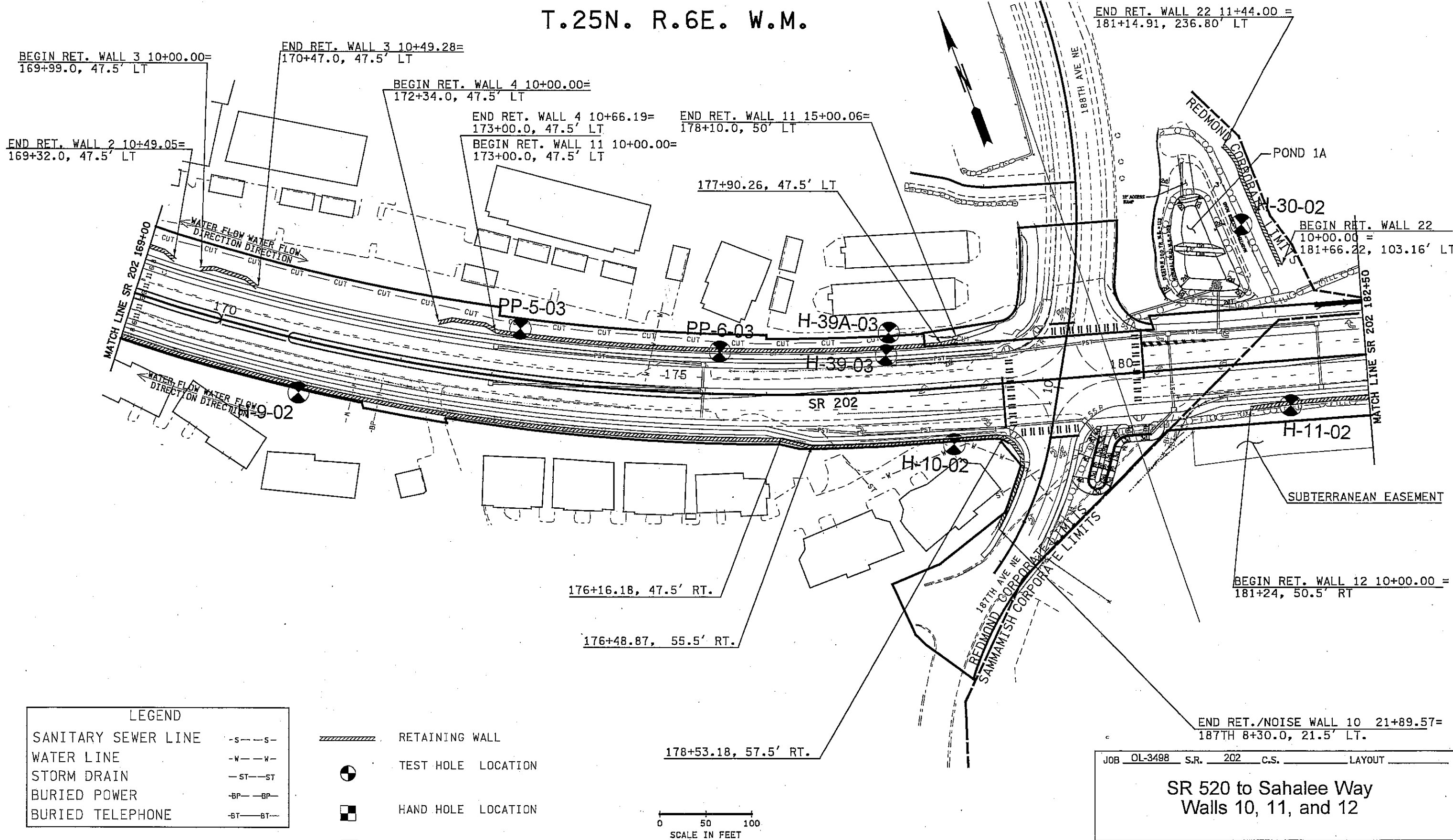
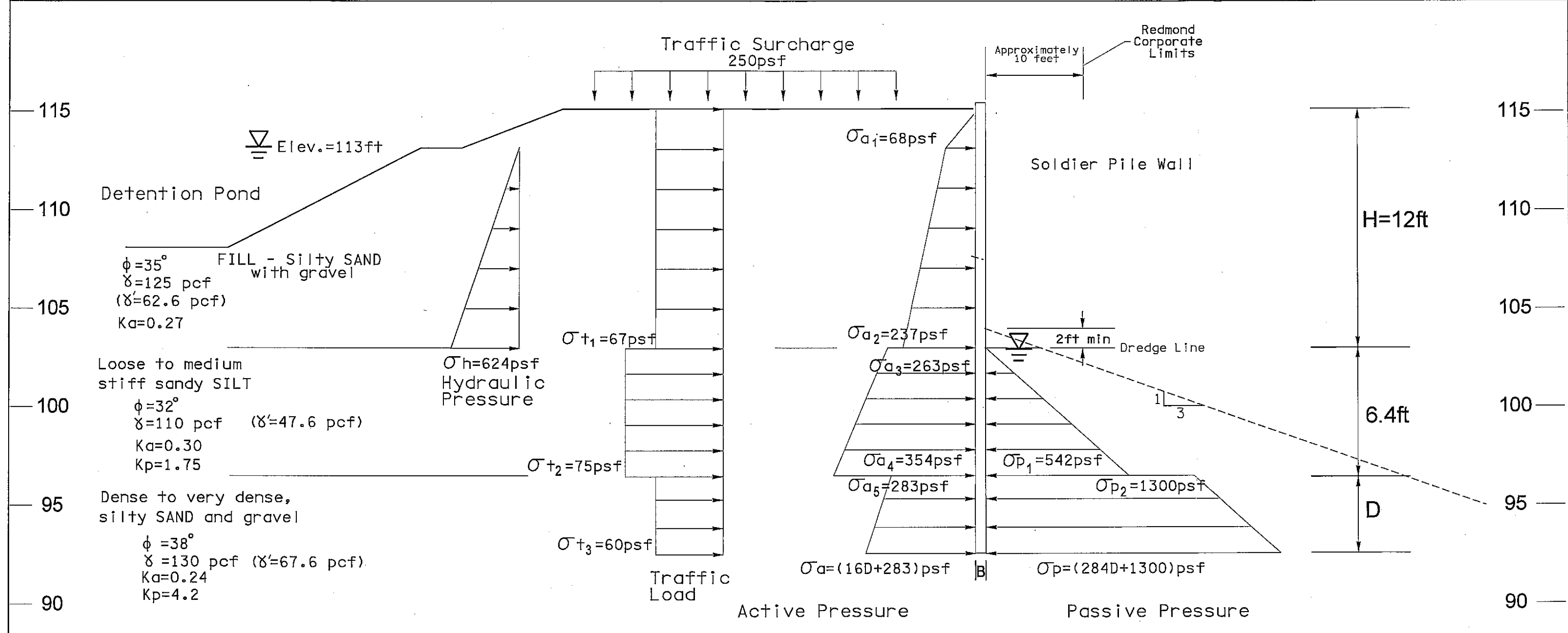



Figure A-10: Site and Exploration Plan

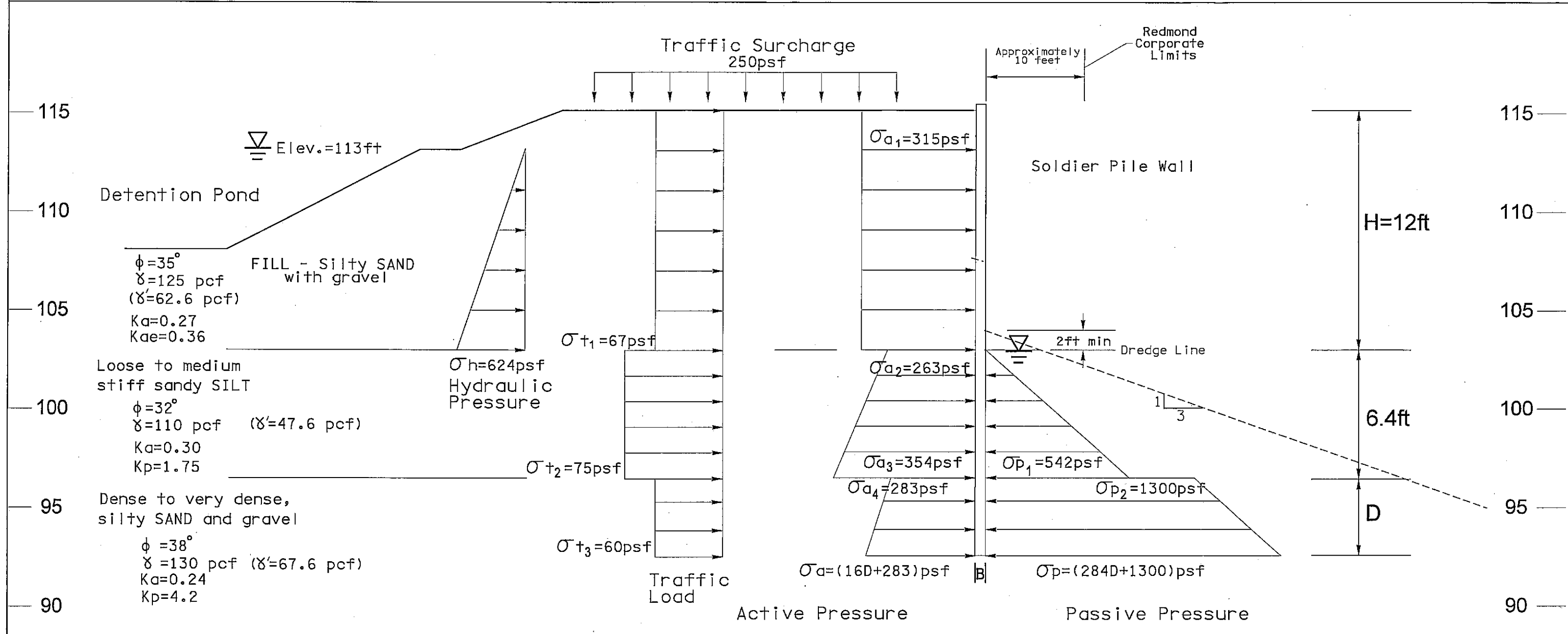
APPENDIX - G



- NOTES: 1: Active pressure is given as $\sigma_a = K_a \gamma H$. Active pressure acts over one soldier pile diameter below the dredge line.
- 2: Passive pressure is given as $\sigma_p = K_p \gamma H$. Passive pressure may be taken to act over three soldier pile diameters where piles are spaced greater than 3B.
- 3: Soil conditions are based on test hole H-30-02.

Figure G-35: Typical Strength Limit State Earth Pressure Diagram for Wall 22, Wall Sta. 10+00 to 11+44

JOB <u>OL-3498</u> S.R. <u>202</u> C.S. <u>1710</u> LAYOUT <u> </u>	
SR 520 TO SAHALEE WAY	
 WASHINGTON STATE TRANSPORTATION COMMISSION DEPARTMENT OF TRANSPORTATION MATERIALS BRANCH T. E. BAKER MATERIALS ENGINEER	DATE <u>1/2004</u> SCALE <u>NOT TO SCALE</u> VERT. <u> </u> HORIZ. <u> </u> SHEET <u> </u> OF <u> </u> DRAWN BY <u>DWG</u>



- NOTES: 1: Active pressure is given as $\sigma_a = K_a \gamma H$. Active pressure acts over one soldier pile diameter below the dredge line.
- 2: Passive pressure is given as $\sigma_p = K_p \gamma H$. Passive pressure may be taken to act over three soldier pile diameters where piles are spaced greater than 3B.
- 3: Soil conditions are based on test hole H-30-02.

Figure G-35A: Typical Extreme Limit State Earth Pressure Diagram
for Wall 22, Wall Sta. 10+00 to 11+44

JOB OL-3498 S.R. 202 C.S. 1710 LAYOUT	
SR 520 TO SAHALEE WAY	
WASHINGTON STATE TRANSPORTATION COMMISSION DEPARTMENT OF TRANSPORTATION MATERIALS BRANCH T. E. BAKER MATERIALS ENGINEER	DATE 1/2004 SCALE NOT VERT. TO HORIZ. SHEET 1 OF 1 DRAWN BY DWG

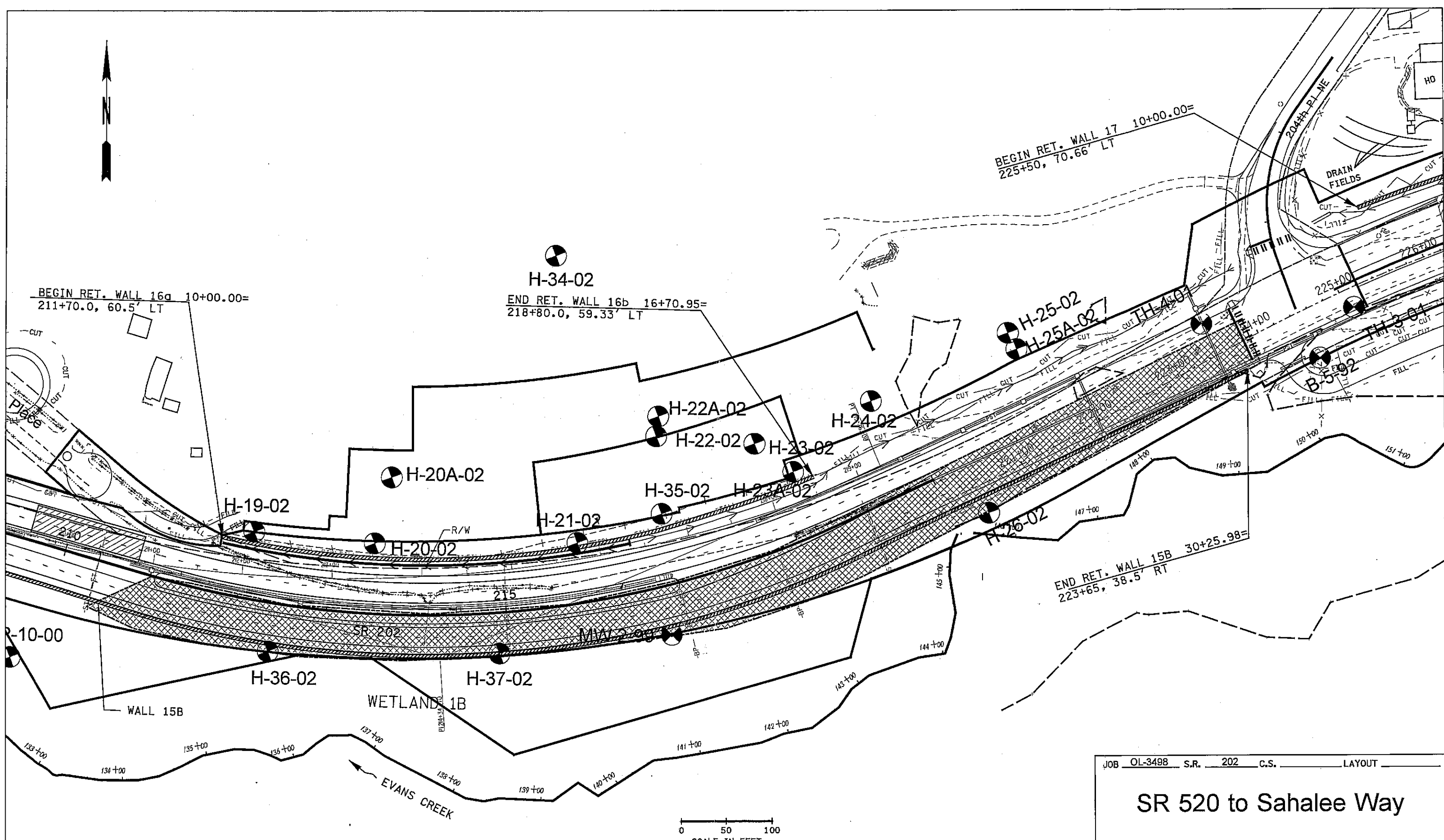



Figure G-36: Approximate Limits of Ground Improvement Behind Wall 15B
Station 210+50 to Station 224+00

JOB OL-3498 S.R. 202 C.S. LAYOUT	
SR 520 to Sahalee Way	
 WASHINGTON STATE TRANSPORTATION COMMISSION DEPARTMENT OF TRANSPORTATION MATERIALS BRANCH T. E. BAKER MATERIALS ENGINEER	DATE 5/2004 SCALE 1"=200' VERT. 1"=200' HORIZ. SHEET ____ OF ____ DRAWN BY DWG

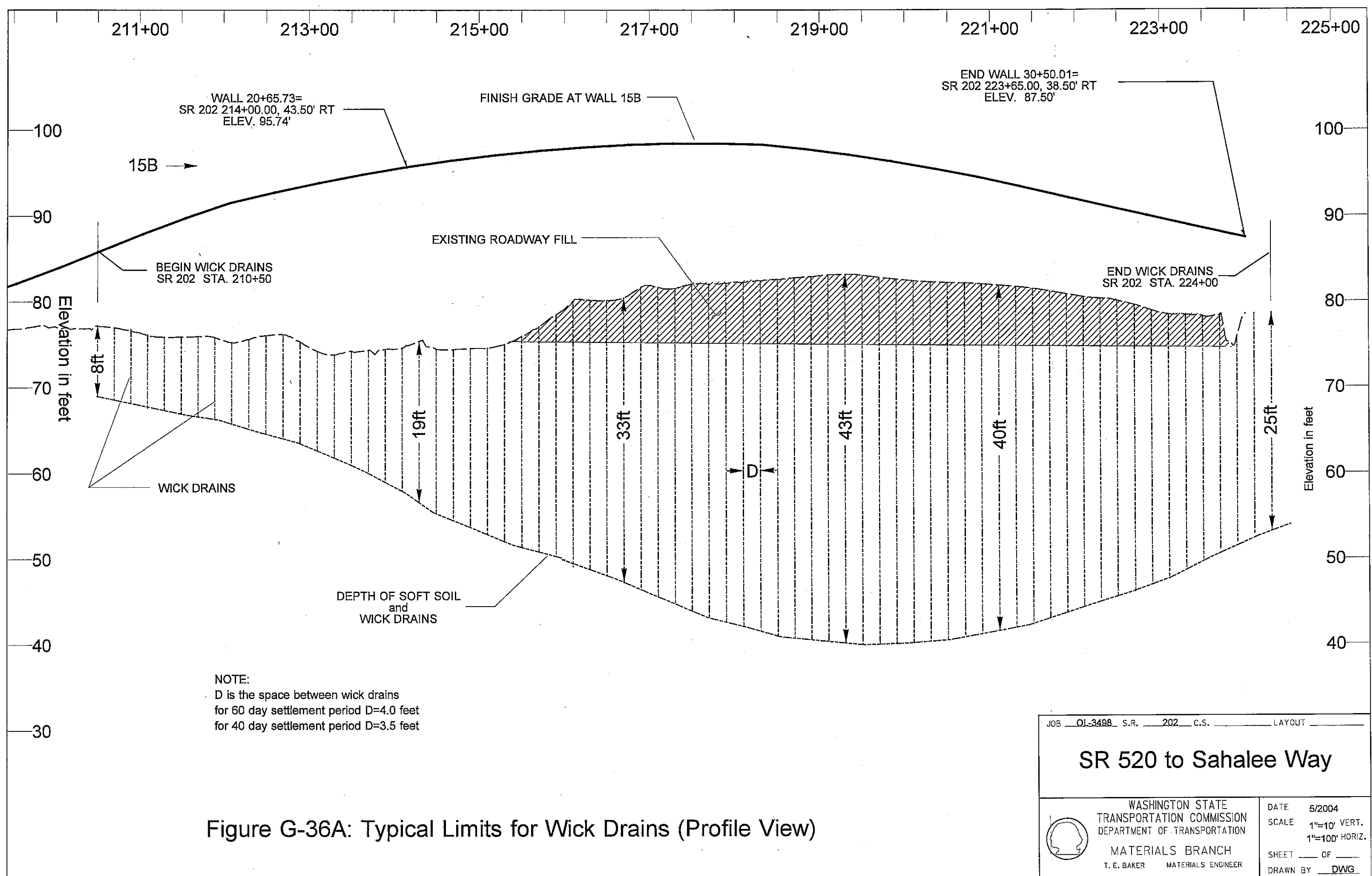
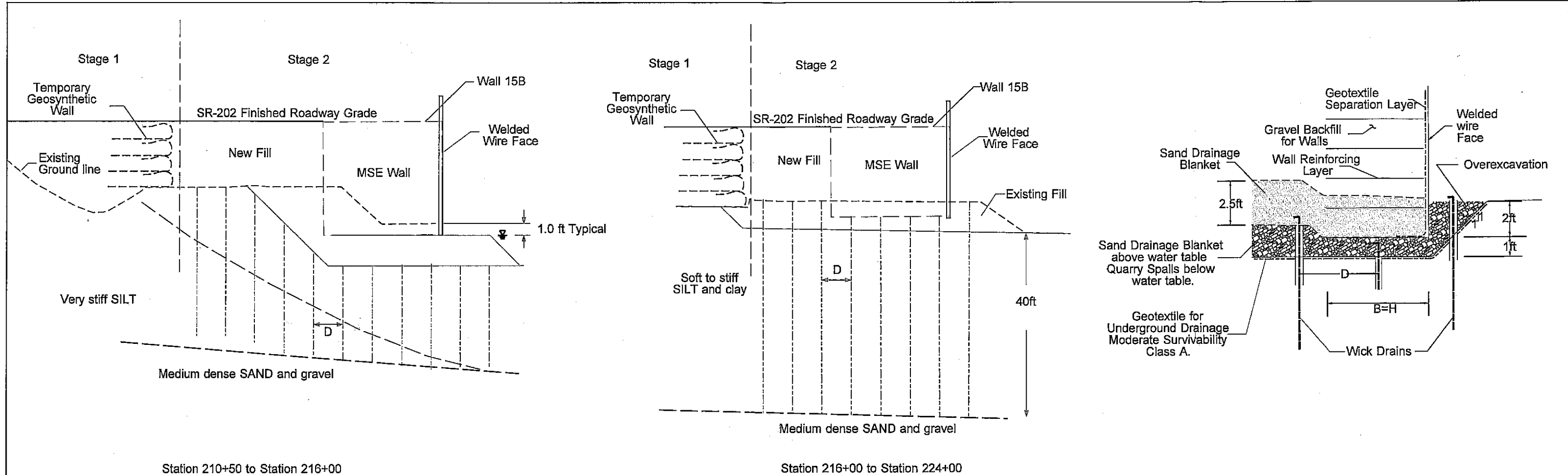



Figure G-36A: Typical Limits for Wick Drains (Profile View)



NOTES:

- 1 Fold wick drains over below first reinforcing layer.
- 2 Back fill and compact wall fill to 95% of maximum density.
- 3 Minimum wall width is a function of ultimate wall height which includes wall settlement.
- 4 See figures G-36 and G-36A for plan limits and spacing of wick drains.

Figure G-36B: Typical Cross Section for Wick Drains
SR-202 Sta. 210+50 to 224+00

JOB OL-3498 S.R. 202 C.S. 1710 LAYOUT	
SR 520 TO SAHALEE WAY	
 WASHINGTON STATE TRANSPORTATION COMMISSION DEPARTMENT OF TRANSPORTATION MATERIALS BRANCH T. E. BAKER MATERIALS ENGINEER	DATE 1/2004 SCALE 1" = 10' VERT. HORIZ. SHEET ____ OF ____ DRAWN BY DWG

APPENDIX - H

SPECIAL PROVISIONS and DETAILS

PREFABRICATED VERTICAL DRAINS (WICK DRAINS)

Description

The Contractor shall furnish and install all necessary labor, equipment and materials, and perform all operations necessary for the wick drains (vertical drains). The drains shall be spaced and arranged as shown on the plans or as otherwise directed by the Engineer.

Materials

The wick drain shall be a prefabricated plastic core wrapped in a filter of non-woven geotextile material. The core shall be fabricated with suitable drainage channels/studs.

The contractor shall submit a 5-foot sample of the vertical drain material to the engineer and shall allow at least three weeks for the Engineer to evaluate the material. The sample shall be stamped or labeled by the manufacture as being representative of the drain having the specified trade name. Approval of the sample material by the Engineer shall be required prior to site delivery of the production drain material.

The materials shall be one of the following products:

Amerdrain (Type 407) (Type 417)	American Wick Drain Corporation 301 Warehouse Drive Matthews, NC 28105 (800) 242-9425 FAX (704) 296-0690
Mebra-Drain (MD 7407) (MD 88)	Nilex Group Pacific Region 3963 Phillips Avenue Burnaby, BC V5A 3K4, Canada (800) 663-6433 FAX (604) 420-0445
Colbondrain (CX -1000)	Colbond Inc. P.O. Box 1057 Enka, NC 28728 (800) 365-7391 FAX (828) 665-5009
Terra-Drain	Terra Systems Inc. 39565 Cottage Grove Lane Lovettsville, VA 20180 (540) 882-4130 FAX (540) 882-3866

The drains shall be free of defects, rips, holes, or flaws. During shipment and storage, the drain shall be wrapped in a heavy-duty protective covering. The storage area shall be such that the drain is protected from sunlight, mud, dirt, dust, debris, and detrimental substances.

Construction Requirements

Equipment

The wick drains shall be installed with equipment that will cause a minimum of disturbance of the subsoil during the installation operation. The wick drains shall be installed using a mandrel or sleeve that will be advanced through the compressible soils to the required depth using vibratory, constant load, or constant rate of advancement methods. Use of falling weight impact hammers will not be allowed. Jetting shall not be permitted within the drainage area. The mandrel shall protect the prefabricated drain material from tears, cuts, and abrasions during installation and shall be withdrawn after the installation of the drain. The mandrel shall be provided with an "anchor" plate or rod at the bottom to prevent soil from entering the bottom of the mandrel during the installation of the drain and to anchor the bottom of the drain at the required depth at the time of removal of the mandrel. The mandrel shall have a maximum cross-sectional area of 12 square inches.

Preconstruction Conference

1. A preconstruction conference shall be held at least five working days prior to the Contractor beginning any wick drain construction work at the site to discuss construction procedures, personnel, and equipment to be used, and other elements of the approved shaft installation plan as specified below. The list of materials specified in the Record of Materials (ROM) form for this item of work will also be discussed. Those attending shall include:
 - a. (representing the Contractor) The superintendent, on site supervisors, and all foremen in charge of wick drain installation.
 - b. (representing the Contracting Agency) The Project Engineer, key inspection personnel, and representatives from the WSDOT Construction Office and Materials Laboratory Geotechnical Branch.
2. If the Contractor's key personnel change, or if the Contractor proposes a significant revision of the approved shaft installation plan, an additional conference shall be held before any additional wick drain construction operations are performed.

Submittals

- A. Construction Experience

1. Prior to the start of wick-drain installation, the Contractor shall submit four copies of a project reference list to the Engineer for approval verifying the successful completion by the Contractor of at least three separate foundation projects where wick drains were successfully installed to equal or greater depth, in similar soil conditions and spacing as shown in the Plans. A brief description of each project and the owner's contact person's name and current phone number shall be included for each project listed.
2. Prior to the start of wick drain construction, the Contractor shall submit four copies of a list identifying the on-site supervisors, and equipment operators assigned to the project to the Engineer for approval. The list shall contain a detailed summary of each individual's experience in wick drain installation.
 - a. On-site supervisors shall have a minimum two years experience in supervising construction of wick drains of similar size (diameter and depth) and scope to those shown in the Plans, and similar geotechnical conditions to those described in the geotechnical report and summary of geotechnical conditions. The work experience shall be direct supervisory responsibility for the on-site wick drain construction operations. Project management level positions indirectly supervising on-site wick drain construction operations is not acceptable for this experience requirement.
 - b. Equipment operators shall have a minimum one year experience in construction of wick drains.
3. The Engineer will approve or reject the Contractor's qualifications and field personnel within 10 working days after receipt of the submission. Work shall not be started on any wick-drain until the Contractor's qualifications and field personnel are approved by the Engineer. The Engineer may suspend the wick drain installation if the Contractor substitutes unqualified personnel. The Contractor shall be fully liable for the additional costs resulting from the suspension of work and no adjustments in contract time resulting from the suspension of work will be allowed.

B. Wick Drain Installation Plan

The Contractor shall submit four copies of a work plan narrative for approval by the Engineer. In preparing the narrative, the Contractor shall reference the available subsurface data provided in the contract test hole boring logs, the Summary of Geotechnical Conditions provided in the Appendix to the Special Provisions, and the geotechnical report(s) prepared for this project. This narrative shall provide at least the following information:

1. An overall construction operation sequence and the sequence of proposed installation procedure.
2. List, description and capacities of proposed equipment, including but not limited to size, type, weight, maximum pushing force, vibratory hammer rated energy, and configuration of the installation rig, the dimensions and length of the mandrel, and details of shoe and proposed method(s) of drain anchorage. The narrative shall describe why the equipment was selected, and describe equipment suitability to the anticipated site and subsurface conditions. The narrative shall include a project history demonstrating the successful use of the equipment in similar soil conditions.
3. Details of proposed methods for overcoming obstructions. This shall include a review of method suitability to the anticipated site and subsurface conditions.
4. Details of proposed method(s) for splicing drains.

Additional Construction Requirements

Where shown on the plans or as directed by the Engineer, wick drains shall be constructed prior to the embankment and/or wall construction. Prior to the installation of wick drains, the Contractor shall stake the proposed locations of the drains and then take all reasonable precautions to preserve the stakes. The locations of the drains shall not vary by more than 6 inches from the locations indicated on the plans or as directed by the Engineer.

The Contractor shall demonstrate that his equipment, method, and materials produce a satisfactory installation in accordance with this specification. For this purpose the Contractor will be required to install 2 trial drains at the locations within the work area designated by the Engineer.

The wick drains shall be constructed to depths as shown on the plans or as directed by the engineer. Drains that deviate from the plan location by more than 6 inches, or that are damaged, or improperly installed, will be rejected. Rejected drains may be removed or abandoned in place, at the Contractor's option, except that rejected drains that interfere with the installation of replacement drains shall be removed. All rejected drains will be replaced at the contractor's expense.

The wick drains shall be installed in a sequence such that equipment will not travel over previously installed drains. Any drains that are damaged by the contractor's operations shall be replaced at the contractor's own expense. The drains shall be installed vertical from the working surface to the elevations shown on the plans or as ordered by the engineer. The contractor shall provide the engineer with a suitable means of verifying the plumbness of the equipment and determining the depth of the drain at any time. The equipment shall be carefully checked for plumbness and shall not deviate more than 1 inch per foot from the vertical.

Splices or connections in the wick drain material shall be done in a workmanlike manner so as to insure continuity of the wick material. The wick drain shall be cut such that at least 6-inch length protrudes above the working surface at each wick drain location.

Where obstructions are encountered below the working surface that cannot be penetrated, the Contractor shall abandon the hole. At the direction of the engineer, the Contractor shall install a new drain within 18 inches of the obstructed drain. A maximum of two attempts shall be made as directed by the Engineer for each obstructed drain.

Installation of the drains should consider and be coordinated with the geotechnical instrumentation and existing utilities shown on the plans. Special care should be taken to install drains in such a manner so as not to disturb instrumentation or utilities already in place. The Contractor will stop all wick drain installation work until the damage is repaired. The replacement of instrumentation or utilities damage as a result of the contractor's construction activities will be the responsibility of the contractor.

Drainage Blanket

Due to the relatively impermeable nature of the surface soil, a working platform of granular soil shall be placed on the ground surface for use as a drainage blanket. This working platform shall have a minimum depth of 2 ft and shall consist of compacted material meeting the requirement of Sand Drainage Blanket in Section 9-03.13(1) of the Standard Specifications.

Measurement

The linear feet for satisfactorily installed drain from the top of the working platform design elevation to the design elevation of the tip of the drain will measure prefabricated drains.

In case of obstructions, the contractor shall be paid at the contract unit price for the number of linear feet of the drain measured from the top of working platform to the elevation at which the obstruction was encountered.

Payment

The unit contract price per lineal foot for "Wick Drain" shall be full pay for furnishing and installing the drains, furnishing all tools, materials, labor, and equipment. Any altering of the equipment and methods of installing the drains to produce the required end result in accordance with the plans shall be considered as incidental cost. No direct payment will be made for unacceptable drains or for any delays or expenses incurred through changes necessitated by improper or unacceptable material or equipment.